Science Benchmark: 06 :06

Heat, light, and sound are all forms of energy. Heat can be transferred by radiation, conduction and convection. Visible light can be produced, reflected, refracted, and separated into light of various colors. Sound is created by vibration and cannot travel through a vacuum. Pitch is determined by the vibration rate of the sound source.

Standard 06:

Students will understand properties and behavior of heat, light, and sound.

Objective 1:

Investigate the movement of heat between objects by conduction, convection, and radiation.

Activity 1: Heat & Color

Intended Learning Outcome:

1-Use science process and thinking skills
4-Communicate effectively using science language and reasoning
6-Understand the nature of science

Teacher Background:

Heat transfer occurs in three different ways: conduction, convection and radiation. These three types of heat transfer often work in combination with each other. The following activity will allow students to identify heat transfer in all three ways. They will also discover how color affects heat. This activity can be completed using one container at a time or several. Make sure that the temperature and other conditions are the same when starting. Point out to students that this activity is easily replicated to check the results.

Materials:

- three or more shallow containers (pie plates, Styrofoam meat containers, etc.)
- food coloring
- thermometers (one for each container)
- paper towels
- heat lamp or incandescent lamp (desk lamp) or natural sunlight
- journal

Invitation to Learn:

Have you ever walked across your lawn on a hot summer day in bare feet? Have you stepped onto an asphalt street and started to hop around? Why is the lawn comfortable and the street uncomfortable?

Instructional Procedures:

1. Have students record in their journals the steps they take during the experiment. Encourage them to make drawings.
2. Place the three dishes next to each other.
3. Put a thermometer in each dish.
4. Cover the thermometer with the same amount of water in each dish.
5. Use food coloring to dye the water in each container a different color.
6. Record the temperature of the water before placing the heat source over the dishes. Make sure the water in each container starts at the same temperature before turning on the light.
7. Place the lamp over the dishes so that it lights them evenly. This could also be done outdoors on a nice day or in a window.
8. Measure and record the temperature every 30 seconds until it stabilizes.
9. Have students observe, describe, and carefully record all stages of the experiment.
10. Each group should report their findings to the class.

Possible Extensions/Adaptations/Integration:

- Have different groups measure and record different colors.
- Experiment with different shades of the same color.
- Compare the amount of time it takes the water to cool to the starting temperature.
- Compare how fast different colors heat and cool over time.

Assessment Suggestion:

The following rubric could be used or adapted for grading this activity.

Description						**Total**
Student set up demonstration correctly.	5	4	3	2	1	
Student's journal showed understanding in writing.	5	4	3	2	1	
Student's journal showed understanding with pictures/drawings.	5	4	3	2	1	
Student's journal showed evidence of self-learning.	5	4	3	2	1	
Oral report activity.	5	4	3	2	1	

Additional Resources:

Science Benchmark: 06 :06

Heat, light, and sound are all forms of energy. Heat can be transferred by radiation, conduction and convection. Visible light can be produced, reflected, refracted, and separated into light of various colors. Sound is created by vibration and cannot travel through a vacuum. Pitch is determined by the vibration rate of the sound source.

Standard 06:

Students will understand properties and behavior of heat, light, and sound.

Objective 1:

Investigate the movement of heat between objects by conduction, convection, and radiation.

Activity 2: Solar Oven

Intended Learning Outcome:

1-Use science process and thinking skills
2-Manifest scientific attitudes and interests
4-Communicate effectively using science language and reasoning

Teacher Background:

It's possible to fry an egg on a sidewalk, but you need a very hot, sunny day and the cooking process takes a while. Using a solar oven is more efficient. You've probably taken a magnifying glass and focused sunlight through it to burn paper. The curved reflector in a solar oven does about the same thing, concentrating all the sunlight that strikes it into a very hot spot near the center of the oven. The efficiency of an oven made from a bowl is affected by the size and shape of the bowl; a continuous curve shape will focus the parallel rays of sunlight better. Both homemade solar ovens will be affected by how smoothly you're able to apply the aluminum foil. Be aware of things you can't control, like the movement of the sun. (You can tell the sun is moving by watching the oven's shadow.) As the sun moves, so does the oven's "hot spot", so adjust the oven accordingly. Ideally, the reflector should point directly at the sun at all times.

Materials:

- mixing bowl or salad bowl (wooden bowls are good because they are often rounded without the flat bottom usually found in plastic or glass bowls)
- aluminum foil
- doubled-sided tape
- 20 cm x 35 cm sheet of flexible cardboard
- 1 m of string
- scissors
- marshmallows
- long forks or skewers

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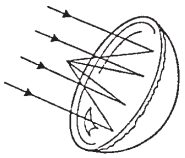
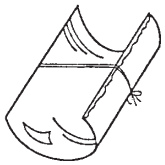
Instructional Procedures:



1. Never look directly at the sun or at reflected, focused sunlight. It can damage your eyes permanently.
2. Design One: Line the inside of a large bowl with aluminum foil, shiny side up. Use several small pieces of double-sided tape to secure the foil. Press the foil close to the bowl and make it as smooth as possible.
3. Design Two: Cover one side of a sheet of cardboard with aluminum foil, shiny side up, securing the foil with double-sided tape. Bend the cardboard into a semicircle, with the foil on the inside of the curve. Wrap a length of string twice around the cardboard semicircle and knot the string at the back.



4. Face both ovens into the sun. You may want to prop up and angle the cookers by making a base with Plasticine. Find each oven's "hot spot", the spot where the sun's reflected rays crisscross. Different ovens have different hot spots. To find the bowl oven's hot spot, slowly put you open hand into the bowl until you feel the hot spot; **don't hold your hand in the hot spot!** You'll probably find the cardboard oven's hot spot near the middle of the string, closer to the foil.
5. Put marshmallows on the end of long skewers and hold a marshmallow in each oven's hot spot. Which oven cooks a marshmallow the fastest? Can you alter an oven to make it work better (e.g. change curve of cardboard)?

Possible Extensions/Adaptations/Integration:

Have students go home and recreate their own solar oven. Retest their new ovens and compare results with ovens made in class.

Assessment Suggestion:

The following rubric could be used or adapted for grading this activity.

Teacher Note:
You will be assessing each student's progress on an ongoing basis. Use the response levels to help you evaluate the student's growth toward the Key Scientific Concepts, the Communication Characteristics and Learning Dispositions.

Response Levels:
1. Accomplishes the purposes of the question, task or concept.
2. Partially accomplishes the purposes of the question, task or concept.
3. Shows fragmented understanding; uses vague scientific communication.

Key Scientific Concepts to Discover:
1. Heat travels across space from the sun to Earth by radiation.
2. Heat energy transfers through Earth's atmosphere.

Communication Characteristics:

1. How complete were the student's recordings?
2. Did the student's drawings make sense?
3. Did the student's recordings reflect awareness of Key Scientific Concepts?

Learning Dispositions:

1. Did the student show perseverance and attention to detail when working on the tasks?
2. Did the student show awareness of science process as they worked on the tasks?

Science Benchmark: 06 :06

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Standard 06:

Students will understand properties and behavior of heat, light, and sound.

Objective 1:

Investigate the movement of heat between objects by conduction, convection, and radiation.

Activity 3: Too Hot to Handle

Intended Learning Outcomes:

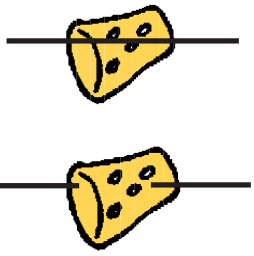
1-Use science process and thinking skills
2-Manifest scientific attitudes and interests
3-Understand science concepts and principles

Teacher Background:

In this demonstration, students will get their first look at both conduction and insulation. Conduction is the passing of heat from one molecule to the other, while insulation is a material that slows or stops the heat from moving. In this activity, use caution to be sure students remove wire as it gets warm.

Materials:

- two corks
- two six inch lengths of stiff wire
- candle
- journal



Instructional Procedures:

1. Before starting, have the materials prepared.
2. One length of wire should be pushed all the way through one of the corks.
3. One length of wire should be cut in half. Push half into the cork from each end making sure they do not touch. Do not tell the students about this wire. They should think both wires are the same. (You, the teacher, need to know which cork is which.)
4. Choose two students to help with the demonstration.
5. Give the cork that has the wire pushed all the way through to one of the students.
6. Give the other cork, wires not touching, to the other student.
7. Light the candle. **Be sure students have safety goggles on and are safety concious with the open flame.**

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8. Ask the students to hold one end of their wires over the flame.
9. Have students tell when their wires begin to get warm.
10. When the wires begin to get warm, have them remove the wires from the flame.
11. Have students write in their journals and explain the results.
12. Discuss conduction and insulation, then let the students modify their journals. (It is up to you, the teacher, to decide how much information to give about this demonstration.)

Possible Extensions/Adaptions/Integration:

- Have students list as many conductors as they can. Circle the best conductors.
- Have students list as many insulators as they can. Circle the best insulators.

Assessment Suggestion:

The following rubric could be used or adapted for grading this activity.

Description						**Total**
Number of conductors listed	5	4	3	2	1	
Number of insulators listed	5	4	3	2	1	
Student's journal showed understanding with pictures/drawings.	5	4	3	2	1	
Student used complete sentences/ correct/spelling/neatness	5	4	3	2	1	
Oral interview of activity.	5	4	3	2	1	

Additional Resources:

A Chilling Story: How Things Cool Down
by Eve & Albert Stwertka; illustrated by Mena Dolobowsky
Jilian Messner/Simon & Schuster, New York 1991
Grades 4-8

Catch the Wind: All About Kites
by Gail Gibbons
Little, Brown & Co., Boston. 1989
4-8

Einstein Anderson Lights Up the Sky
by Seymour Simon; illustrated by Fred Winkowski
Viking Press, New York. 1982
Grades 4-7

Einstein Anderson Shocks His Friends
by Seymour Simon; illustrated by Fred Winkowski
Viking Press, New York. 1980
Grades 4-7

Einstein Anderson Tells a Comet's Tale
by Seymour Simon; illustrated by Fred Winkowski
Viking Press, New York. 1980
Grades 4-7

June 29, 1999
by David Wiesner
Clarion Books, Houghton Mifflin, New York. 1992
Grades 2-6

Have Spacesuit, Will Travel
by Robert A. Heinlein
Charles Scribner's Sons, New York. 1958

Science Benchmark: 06 :06

Heat, light, and sound are all forms of energy. Heat can be transferred by radiation, conduction and convection. Visible light can be produced, reflected, refracted, and separated into light of various colors. Sound is created by vibration and cannot travel through a vacuum. Pitch is determined by the vibration rate of the sound source.

Standard 06:

Students will understand properties and behavior of heat, light, and sound.

Objective 2:

Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.

Activity 4: Lemon Light

Intended Learning Outcomes:

1-Use science process and thinking skills
3-Understand science concepts and principles
4-Communicate effectively using science language and reasoning

Teacher Background:

Light moves in a straight line from its source unless it is refracted. Light can be bent or refracted by the medium it travels through. The refraction of light can be modeled in several ways. One way is to use a prism and shine a light through it. The colors are separated as each color bends at a different angle. Another way refraction can be observed is to look at a pencil that is placed in a cup of water. The pencil appears bent as the light waves slow down in the water. The path of refracted light can be seen through Jell-O. This activity will model different types of refraction.

Materials:

- 1 8 oz. package of lemon gelatin (Jell-O) mixed with 1.5 cups of boiling water (to make enough Jell-O for a class of 30, use 4 packages of lemon Jell-O and 6 cups of water and fill a 14 x 17 inch cookie sheet)
- can, hard plastic cup, or circular cookie cutter
- plastic knife-one per pair of students
- 3 x 5 card with 3 small slits cut in it (one per student pair)

- prism
- small flashlight (one per student pair)
- laser pointer (Due to potential safety hazard to eyes, laser pointer should be used by teacher only and with caution.)
- butcher paper or wax paper
- pencil

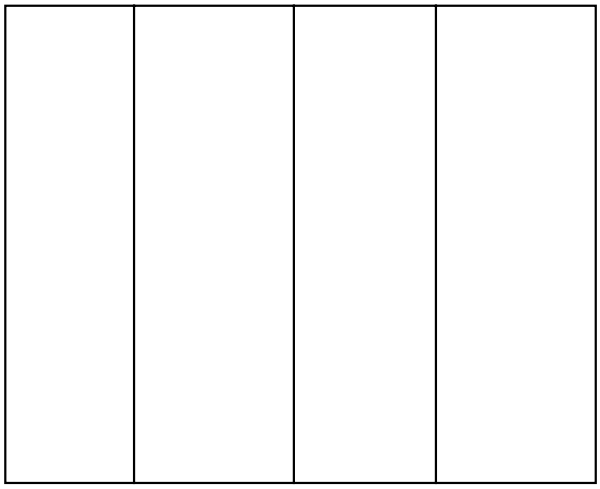
Invitation to Learn:

1. Use a laser pointer in a dark room. Point it across the room. Have a student clap two chalk erasers together near the beam of light. Ask students what they can observe about the light.
2. Use a flashlight and shine it through the prism. Aim the refracted light at a screen or white wall. Ask students what they observe about the light.
3. Demonstrate with a pencil and cup of water how the pencil appears to bend when immersed in water.
4. Make a KWL chart about light. Students should list in columns what they know ("K") about the light and what they want ("W") to know. The "L" column will be filled in later with what they learned.

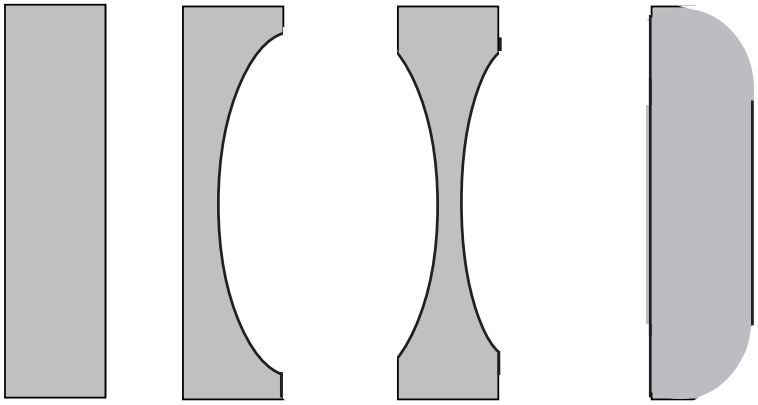
Instructional Procedures:

1. Advance Preparation: Mix the Jell-O; pour Jell-O 1 1/2-inches thick into a shallow pan. Allow set-up the night before. A 14 x 17 inch cookie sheet makes enough for the whole class.
2. Cover student desks with butcher paper or wax paper.
3. Give pairs of students a flashlight, the 3 x 5 card and a square of Jell-O gelatin that is 4 inches square in size.
4. Explain to students that light travels differently through different mediums. Have them predict what will happen to light as it travels through the Jell-O.
5. Students will need to cut 4 strips from the Jell-O and lay them on the wax paper. Have students cut the strips into the shapes shown below (A). Use the can, cup or cookie cutter to cut circles on the edges of the strips to make the shapes on the following page (B).

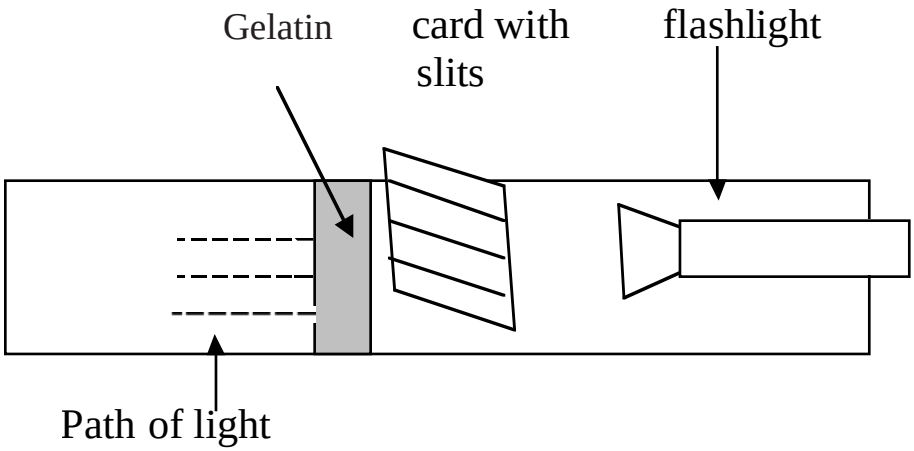
(A) Cut four strips.



(B) Cut these shapes.



5. The light must shine through the slits in the 3 x 5 card as it shines through the Jell-O.



6. Students should draw the path of the light beams on the butcher paper as it leaves the Jell-O. They should record all observations in their journals.
7. Finish the KWL chart at the end of the activity.

Possible Extensions/Adaptations/Integration:

Students may wish to test the path of light through other transparent mediums.

Assessment Suggestions:

The following rubric could be used or adapted for grading this activity.

Teacher Note:
You will be assessing each student's progress on an ongoing basis. Use the response levels to help you evaluate the student's growth toward the Key Scientific Concepts, the Communication Characteristics and Learning Dispositions.

Response Levels:
1. Accomplishes the purposes of the question, task or concept.
2. Partially accomplishes the purposes of the question, task or concept.
3. Shows fragmented understanding; uses vague scientific communication.

Key Scientific Concepts to Discover:
1. Light may be bent or refracted by the medium through which it travels.
2. Refraction of light is modeled in several ways.
3. Refraction may be observed and documented.

Communication Characteristics:
1. How complete were the student's recordings?
2. Did the student's drawings make sense?
3. Did the student's recordings reflect awareness of Key Scientific Concepts?

Learning Dispositions:
1. Did the student show perseverance and attention to detail when working on the tasks?
2. Did the student show awareness of science process as they worked on the tasks?

Additional Resources:

http://nyelabs.kcts.org/nyeverse/l
http://www.scienceow.org
http://www.odin.phys.bris.ac.uk8080
http://www.exploratorium.edu/

Fireflies in the Night
by Judy Hawes; illusrtated by Ellen alexander
Harper & Row, New York. 1963, 1991
Grades K-5

Einstein Anderson Sees Through the Invisible Man
by Seymour Simon; illustrated by Fred Winkowski
Viking Press, New York. 1983
Grades 4-7

Science Benchmark: 06 :06

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Standard 06:

Students will understand properties and behavior of heat, light, and sound.

Objective 3:

Describe the production of sound in terms of vibration of objects that create vibrations in other materials.

Activity 5: Sound Waves

Intended Learning Outcomes:

1-Use science process and thinking skills

4-Communicate effectively using science language and reasoning

Teacher Background:

The pitch of a sound is determined by the size (length, thickness) of the object making the sound. This is true of the voice boxes of animals. For example: women usually have shorter vocal cords than men and have higher pitched voices as a result.

Sound waves can be "seen" if they are translated into light. In the second half of this activity, you will find a description of this process.

Materials:

- juice can
- large balloon
- small mirror
- rubber cement
- rubber band
- flashlight

Invitation to Learn:

1. Leader whispers the name of a different animal in each person's ear (e.g., cat, bird, dog, donkey, elephant, owl, pig, horse).
2. Each person takes a few seconds to practice the noise that his/her animal makes.
3. One at a time, each person makes his/her sound and then arranges himself/herself in a line according to the sound of the animal's pitch — highest to lowest.
4. After the line has formed, draw a connection between the pitch of the animal's voice and the size of the animal. Pitch is determined by the length and thickness of the animals vocal cords. Larger animals tend to have larger vocal cords.

Instructional Procedures:

1. In student science journal, have each student describe what he/she observes as he/she watches the demonstration.
2. Stretch a balloon over one end of a soup can from which both ends of the can have been removed.
3. Rubber cement a small mirror to the rubber sheet, and set up the can so that sound may enter the can and vibrate the membrane with the mirror attached.
4. Aim a beam of light at the mirror so that it reflects to a screen or white wall.
5. Have a student sing into the can and see the sound patterns of his/her own voice. Do not attempt an explanation
6. Encourage students to think about what the rubber sheet was doing. Record observations in detailed scientific language in student science journal.

Science Benchmark: 06 :06

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Standard 06:

Students will understand properties and behavior of heat, light, and sound.

Objective 3:

Describe the production of sound in terms of vibration of objects that create vibrations in other materials.

Activity 6: Sound Vibrations

Intended Learning Outcomes:

1-Use science process and thinking skills
3-Understand science concepts and principles
4-Communicate effectively using science language and reasoning

Teacher Background:

Whenever something vibrates it is creating sound. The sound travels in the form of a wave through a medium. The medium is anything that has molecules touching each other. If there is no medium, there is no sound. In the following demonstration students will be able to see the sound waves as they cause the salt to dance on the plastic wrap. They will also hear the tapping as the sound wave reaches their eardrums. Sound waves travel through air and cause plastic wrap to wiggle.

Materials:

- two #10 cans from the cafeteria (label them can #1 and can # 2)
- plastic food wrap to cover one can
- large rubber band
- salt
- spoon
- journal

Invitation to Learn:

You have all heard a siren, a blast from a firework, a dog bark and the song of a bird. But have you ever wondered how the sound got to you? Or how about an echo? How do you hear the same word more than one time? The following activity should help you answer these questions.

Instructional Procedures:

1. Stretch the plastic wrap over the top of one can #1. Pull it tightly so it is smooth like a drum. Use the rubber band to help hold it in place. (You can seal the plastic wrap to a glass container in place of the can and rubber band.)
2. Sprinkle salt on the plastic wrap.
3. With opened end down of can #2, hold can #2 about 3" above can #1. (The closed end is now up.)
4. While you are holding can #2, tap the closed end with a spoon, like you would a drum.
5. Have students describe in their journals what happened.

Possible Extensions/Adaptations/Integration:

- Move the can you tapped to different angles and record what happens.
- Will the salt dance using objects that do not focus the sound as the can does?
- Have students design an experiment that creates an echo (Sound waves bouncing back to the same point).

Assessment Suggestion:

The following rubric could be used or adapted for grading this activity.

Description						**Total**
Student set up demonstration correctly.	5	4	3	2	1	
Student's journal showed understanding in writing.	5	4	3	2	1	
Student's journal showed understanding with pictures/drawings.	5	4	3	2	1	
Student's journal showed evidence of self-learning.	5	4	3	2	1	
Oral report activity.	5	4	3	2	1	

Additional Resources:

Science Benchmark: 06 :06

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Standard 06:

Students will understand properties and behavior of heat, light, and sound.

Objective 3:

Describe the production of sound in terms of vibration of objects that create vibrations in other materials.

Activity 7: Battle of the Bands

Intended Learning Outcomes:

3-Understand science concepts and principles
4-Communicate effectively using science language and reasoning

Teacher Background:

This activity will allow students to create instruments from materials provided by the teacher or found in and around their homes. They will make and play instruments of their choice. They will also learn and be able to tell how each of the instruments in their band creates sound. Get ready for a few interesting class periods.

Materials:

- bottles
- string
- boxes (shoe box size and smaller)
- utensils
- rubber bands
- scissors
- straws
- other misc. items
- journal

Invitation to Learn:

How did musical instruments get started? Who made the first musical instruments? What kinds of musical instruments could you make from materials in your home? What kinds of musical instruments could you make from the materials in the classroom?

Instructional Procedures:

1. Show the class your set of materials and have them think of ways they could make musical instruments out of them. (If you have several sets of the same or miscellaneous items, pass them out to groups and have them make musical instruments.)
2. Have students brainstorm instruments they could build from materials around their homes. Each group should bring items to school to create their own band and perform for the class.
3. Explain the rules/requirements.
    - Each student must have an instrument made of common items found around the house/neighborhood. (Items can be brought to school to make the instrument, or the instrument could be assigned as homework.)
    - Each student in the group must play his/her instrument in the group's band
    - Each group must play a recognizable tune (nursery rhyme, folk song, TV theme, Disney tune, etc.).
    - Each student in the group should be able to tell how all instruments in the group produce sound.
    - Each student must keep a journal of the steps he/she took in creating his/her band.
4. Use one class period for the "Battle of the Bands." Each band gets a fixed amount of time for their performance. (5-10 min.)

Possible Extensions/Adaptations/Integration:

- Create a classroom orchestra/band from all groups.
- Have students create a "One Man Band."
- Create instruments similar to those being studied in the social studies curriculum
- Travel to other classes to perform songs.

Assessment Suggestion:

The following rubric could be used or adapted for grading this activity.

Description						**Total**
Student set up demonstration correctly.	5	4	3	2	1	
Student's journal showed understanding in writing.	5	4	3	2	1	
Student's journal showed understanding with pictures/drawings.	5	4	3	2	1	
Student's journal showed evidence of self-learning.	5	4	3	2	1	
Oral report activity.	5	4	3	2	1	

Additional Resources: